Elastic properties of disordered solids below 100K

M. Saint-Paul
CRTBT CNRS , associé à l'UJF BP 166 38042 Grenoble cedex 9 France

A common feature of amorphous and disordered solids at temperature above 5K is the linear decrease of the sound velocity with inceasing temperature
[1, 2]. This feature has been reported for insulating, metallic and polymeric glasses. It has also been observed in disordered solids such as quasicrystals. Classical tunneling relaxations are not the only process contribution to the velocity shift in glasses above 5K. It has been suggested that the temperature dependence of the sound velocity could arise from the strong anharmonicity of the disordered lattice.
We report measurements on different solids: random composites, PLZT ceramics and hard carbon formed from C_{60} fullerenes. Following the analysis given in [2], an anharmonic origin of the linear temperature dependence of the sound velocity due to the coupling of the sound wave with unspecified low energy vibrational modes is assumed. Some models of such modes have been considered in the fracton [3] and in the soft-potential formulations[4].

The temperature coefficient of the sound velocity is related to the parameter $n\gamma^2$ where n is the number density of low-energy oscillators and γ is an effective Gruneisen parameter. A similar $n\gamma^2 \approx 1.2 \times 10^{23}$ cm^{-3} value is obtained for many disordered solids [2].

However $n\gamma^2$ is ten times larger in pure silica glasses where it is well known that the temperature dependence of the sound velocity is related to thermally activated relation processes[5].

[1] K.A. Topp, D.G. Cahill Z. Phys. B **101** 235 (1996).
and B.E.White, R.O. Pohl Z. Phys. B. **100** 401 (1996).
[2] R. Nava Phys.Rev. B **49** 4295 (1994).
[3] R.Orbach Philos.Mag. B **65** 289 (1992).
[4] U. Buchenau Philos.Mag. B **65** 303 (1992).
[5] D.Tielburger, R. Mer, R.Ehrenfels, S. Hunklinger Phys. Rev B. **45** 2750 (1992).